

WHAT IS CLAIMED IS:

- 1 1. A method for reducing errors during data processing, comprising:
 - 2 testing at least one number resulting from an incremental calculation of
 - 3 transform coefficients during a transform;
 - 4 determining whether to perform a corrective action based upon the testing;
 - 5 and
 - 6 performing the corrective action when a corrective action is determined to be
 - 7 needed.
- 1 2. The method of claim 1 wherein the determining comprises detecting
- 2 whether the incremental calculation of the transform coefficients will result in
- 3 transform coefficients with unacceptable precision and the performing corrective
- 4 action comprises refining the at least one number.
- 1 3. The method of claim 2 wherein the transform comprises a transform
- 2 matrix and wherein the refining comprises applying a refinement matrix for
- 3 increasing precision of the incremental calculation of the transform constants.
- 1 4. The method of claim 3 wherein the refinement matrix comprises
- 2 $I + {}_d D_{m+1} D_m^{-1}$.
- 1 5. The method of claim 1 further comprising generating at least one
- 2 refinement matrix based on approximately calculated transform constants.

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1 6. The method of claim 5 wherein the generating at least one refinement
2 matrix is performed offline or at initialization.

1 7. The method of claim 5 wherein the generating the at least one
2 refinement matrix comprises recognizing that an approximate transform is invertible,
3 generating the refinement matrix given by $I + {}_d D_{m+1} D_m^{-1}$, and structuring the
4 transform for efficient computation.

1 8. The method of claim 5 wherein the generating the at least one
2 refinement matrix comprises:
3 recognizing that recovery of the nth column of a transform matrix for
4 generating the transform is impossible;
5 calculating a pseudo inverse for a portion of the transform matrix; and
6 generating an approximation for the at least one refinement matrix using the
7 pseudo inverse for the transform matrix.

1 9. The method of claim 8 wherein the approximation of the refinement
2 matrix comprises $I + {}_d D_{1d} \tilde{D}_0$.

1 10. The method of claim 1 wherein the determining whether to perform a
2 corrective action further comprises determining whether an error resulting from
3 terminating the incremental calculation is acceptable and the performing corrective
4 action comprises aborting the incremental calculation of a transform coefficient.

1 11. The method of claim 10 wherein the incremental calculation is
2 terminated when a determination is made that the incremental calculation will result
3 in a number that is projected to be within a predetermined range.

1 12. The method of claim 11 wherein the number that is projected to be
2 within a predetermined range comprises a transform coefficient that does satisfy a
3 precision requirement.

1 13. The method of claim 11 wherein the incremental calculation is
2 terminated when a refinement to the transform coefficient is determined not to
3 change the result.

1 14. The method of claim 13 wherein a refinement to the transform
2 coefficient is determined not to change the result when, after checking the relative
3 magnitudes of the results of the incremental calculations, an intermediate calculation
4 of at least one transform coefficient is small compared to the intermediate calculation
5 of another transform coefficient.

1 15. The method of claim 13 wherein a refinement to the transform
2 coefficient is determined not to change the result when, after checking the
3 magnitude of the results of at least one incremental calculation, at least one
4 intermediate calculation of the transform coefficient is less than a predetermined
5 threshold.

1 16. The method of claim 1 wherein the determining further comprises
2 determining that a transform coefficient is going to be within a predetermined range
3 of zero and the performing corrective action comprises aborting the incremental
4 calculation of the transform coefficient.

1 17. A data compression system, the data compression system comprising
2 a transformer for applying a linear analysis transform to decorrelate data into
3 transform coefficients using transform equations, the transformer reducing errors of
4 the transform by testing at least one number resulting from an incremental
5 calculation of transform coefficients during a transform, determining whether to
6 perform a corrective action based upon the testing and performing the corrective
7 action when a corrective action is determined to be needed.

1 18. The data compression system of claim 17 further comprising a
2 quantizer for quantizing the transformed data into quantized data to reduce a
3 number of bits needed to represent the transform coefficients.

1 19. The data compression system of claim 17 wherein the transformer
2 determines whether to perform a corrective action by detecting whether the
3 incremental calculation of the transform coefficients will result in transform
4 coefficients with unacceptable precision and performs corrective action by refining
5 the at least one number.

1 20. The data compression system of claim 19 wherein the transform
2 comprises a transform matrix and wherein the transformer refines the at least one
3 number by applying a refinement matrix for increasing precision of the incremental
4 calculation of the transform constants.

1 21. The data compression system of claim 20 wherein the refinement
2 matrix comprises $I + {}_d D_{m+1} D_m^{-1}$.

1 22. The data compression system of claim 20 wherein the refinement
2 matrix is based on approximately calculated transform constants.

1 23. The data compression system of claim 22 wherein the refinement
2 matrix is generated offline or at initialization.

1 24. The data compression system of claim 21 wherein the refinement
2 matrix is generated by recognizing that an approximate transform is invertible,
3 generating the refinement matrix given by $I + {}_d D_{m+1} D_m^{-1}$, and structuring the
4 transform for efficient computation.

1 25. The data compression system of claim 21 wherein the refinement
2 matrix is generated by recognizing that recovery of the nth column of a transform
3 matrix for generating the transform is impossible, calculating a pseudo inverse for a
4 portion of the transform matrix and generating an approximation for the refinement
5 matrix using the pseudo inverse for the transform matrix.

1 26. The data compression system of claim 25 wherein the approximation
2 of the refinement matrix comprises $I +_d D_{1d} \tilde{D}_0$.

1 27. The data compression system of claim 17 wherein the transformer
2 determines whether to perform a corrective action by determining whether an error
3 resulting from terminating the incremental calculation is acceptable and performs
4 corrective action by aborting the incremental calculation of a transform coefficient.

1 28. The data compression system of claim 27 wherein the transformer
2 terminates the incremental calculation when a determination is made that the
3 incremental calculation will result in a number that is projected to be within a
4 predetermined range.

1 29. The data compression system of claim 28 wherein the number that is
2 projected to be within a predetermined range comprises a transform coefficient that
3 does satisfy a precision requirement.

1 30. The data compression system of claim 28 wherein the transformer
2 terminates the incremental calculation when a refinement to the transform coefficient
3 is determined not to change the result.

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1 31. The data compression system of claim 30 wherein the transformer
2 determines that a refinement to the transform coefficient will not change the result
3 when, after checking the relative magnitudes of the results of the incremental
4 calculations, an intermediate calculation of at least one transform coefficient is small
5 compared to the intermediate calculation of another transform coefficient.

1 32. The data compression system of claim 30 wherein the transformer
2 determines that a refinement to the transform coefficient will not change the result
3 when, after checking the magnitude of the results of at least one incremental
4 calculation, at least one intermediate calculation of the transform coefficient is less
5 than a predetermined threshold.

1 33. The data compression system of claim 17 wherein the transformer
2 determines that a corrective action is to be determined by determining that a
3 transform coefficient is going to be within a predetermined range of zero and
4 performs corrective action by aborting the incremental calculation of the transform
5 coefficient.

1 34. A printer, comprising:
2 memory for storing image data;
3 a processor for processing the image data to provide a print stream output;
4 and
5 a printhead driving circuit for controlling a printhead to generate a printout of
6 the image data;
7 wherein the processor reduces errors of the transform by testing at least one
8 number resulting from an incremental calculation of transform coefficients during a
9 transform, determining whether to perform a corrective action based upon the testing
10 and performing the corrective action when a corrective action is determined to be
11 needed.

1 35. The printer of claim 34 wherein the processor determines whether to
2 perform a corrective action by detecting whether the incremental calculation of the
3 transform coefficients will result in transform coefficients with unacceptable precision
4 and performs corrective action by refining the at least one number..

1 36. The printer of claim 35 wherein the transform comprises a transform
2 matrix and wherein the transformer refines the at least one number by applying a
3 refinement matrix for increasing precision of the incremental calculation of the
4 transform constants.

1 37. The printer of claim 36 wherein the refinement matrix comprises
2 $I + {}_d D_{m+1} D_m^{-1}$.

1 38. The printer of claim 36 wherein the refinement matrix is based on
2 approximately calculated transform constants.

1 39. The printer of claim 38 wherein the refinement matrix is generated
2 offline or at initialization.

1 40. The printer of claim 37 wherein the refinement matrix is generated by
2 recognizing that an approximate transform is invertible, generating the refinement
3 matrix given by $I + {}_d D_{m+1} D_m^{-1}$, and structuring the transform for efficient computation.

1 41. The printer of claim 37 wherein the refinement matrix is generated by
2 recognizing that recovery of the nth column of a transform matrix for generating the
3 transform is impossible, calculating a pseudo inverse for a portion of the transform
4 matrix and generating an approximation for the refinement matrix using the pseudo
5 inverse for the transform matrix.

1 42. The printer of claim 41 wherein the approximation of the refinement
2 matrix comprises $I + {}_d D_{1d} \tilde{D}_0$.

1 43. The printer of claim 34 wherein the transformer determines whether to
2 perform a corrective action by determining whether an error resulting from
3 terminating the incremental calculation is acceptable and performs corrective action
4 by aborting the incremental calculation of a transform coefficient.

1 44. The printer of claim 43 wherein the transformer terminates the
2 incremental calculation when a determination is made that the incremental
3 calculation will result in a number that is projected to be within a predetermined
4 range.

1 45. The printer of claim 44 wherein the number that is projected to be
2 within a predetermined range comprises a transform coefficient that does satisfy a
3 precision requirement.

1 46. The printer of claim 44 wherein the transformer terminates the
2 incremental calculation when a refinement to the transform coefficient is determined
3 not to change the result.

1 47. The printer of claim 46 wherein the transformer determines that a
2 refinement to the transform coefficient will not change the result when, after
3 checking the relative magnitudes of the results of the incremental calculations, an
4 intermediate calculation of at least one transform coefficient is small compared to the
5 intermediate calculation of another transform coefficient.

1 48. The printer of claim 46 wherein the transformer determines that a
2 refinement to the transform coefficient will not change the result when, after
3 checking the magnitude of the results of at least one incremental calculation, at least
4 one intermediate calculation of the transform coefficient is less than a predetermined
5 threshold.

1 49. The printer of claim 34 wherein the transformer determines that a
2 corrective action is to be determined by determining that a transform coefficient is
3 going to be within a predetermined range of zero and performs corrective action by
4 aborting the incremental calculation of the transform coefficient.

1 50. An article of manufacture comprising a program storage medium
2 readable by a computer, the medium tangibly embodying one or more programs of
3 instructions executable by the computer to perform a method for reducing errors
4 during data processing, the method comprising:

5 testing at least one number resulting from an incremental calculation of
6 transform coefficients during a transform;

7 determining whether to perform a corrective action based upon the testing;
8 and

9 performing the corrective action when a corrective action is determined to be
10 needed.

1 51. The article of manufacture of claim 50 wherein the determining
2 comprises detecting whether the incremental calculation of the transform coefficients
3 will result in transform coefficients with unacceptable precision and the performing
4 corrective action comprises refining the at least one number.

1 52. The article of manufacture of claim 51 wherein the transform
2 comprises a transform matrix and wherein the refining comprises applying a
3 refinement matrix for increasing precision of the incremental calculation of the
4 transform constants.

1 53. The article of manufacture of claim 52 wherein the refinement matrix
2 comprises $I +_d D_{m+1} D_m^{-1}$.

1 54. The article of manufacture of claim 50 further comprising generating at
2 least one refinement matrix based on approximately calculated transform constants.

1 55. The article of manufacture of claim 54 wherein the generating at least
2 one refinement matrix is performed offline or at initialization.

1 56. The article of manufacture of claim 54 wherein the generating the at
2 least one refinement matrix comprises recognizing that an approximate transform is
3 invertible, generating the refinement matrix given by $I + {}_d D_{m+1} D_m^{-1}$, and structuring
4 the transform for efficient computation.

1 57. The article of manufacture of claim 54 wherein the generating the at
2 least one refinement matrix comprises:

3 recognizing that recovery of the nth column of a transform matrix for
4 generating the transform is impossible;
5 calculating a pseudo inverse for a portion of the transform matrix; and
6 generating an approximation for the at least one refinement matrix using the
7 pseudo inverse for the transform matrix.

1 58. The article of manufacture of claim 57 wherein the approximation of
2 the refinement matrix comprises $I + {}_d D_{1d} \tilde{D}_0$.

1 59. The article of manufacture of claim 50 wherein the determining
2 whether to perform a corrective action further comprises determining whether an
3 error resulting from terminating the incremental calculation is acceptable and the
4 performing corrective action comprises aborting the incremental calculation of a
5 transform coefficient.

1 60. The article of manufacture of claim 59 wherein the incremental
2 calculation is terminated when a determination is made that the incremental
3 calculation will result in a number that is projected to be within a predetermined
4 range.

1 61. The article of manufacture of claim 60 wherein the number that is
2 projected to be within a predetermined range comprises a transform coefficient that
3 does satisfy a precision requirement.

1 62. The article of manufacture of claim 60 wherein the incremental
2 calculation is terminated when a refinement to the transform coefficient is
3 determined not to change the result.

1 63. The article of manufacture of claim 62 wherein a refinement to the
2 transform coefficient is determined not to change the result when, after checking the
3 relative magnitudes of the results of the incremental calculations, an intermediate
4 calculation of at least one transform coefficient is small compared to the intermediate
5 calculation of another transform coefficient.

1 64. The article of manufacture of claim 62 wherein a refinement to the
2 transform coefficient is determined not to change the result when, after checking the
3 magnitude of the results of at least one incremental calculation, at least one
4 intermediate calculation of the transform coefficient is less than a predetermined
5 threshold.

1 65. The article of manufacture of claim 50 wherein the determining further
2 comprises determining that a transform coefficient is going to be within a
3 predetermined range of zero and the performing corrective action comprises
4 aborting the incremental calculation of the transform coefficient.

1 66. A data analysis system, comprising;
2 transform equations formed by testing at least one number resulting from an
3 incremental calculation of transform coefficients during a transform, determining
4 whether to perform a corrective action based upon the testing and performing the
5 corrective action when a corrective action is determined to be needed; and
6 a transformer for applying the transform equations to perform a linear
7 transform to decorrelate data into transform coefficients.

1 67. The data analysis system of claim 66 wherein the transformer
2 determines whether to perform a corrective action by detecting whether the
3 incremental calculation of the transform coefficients will result in transform
4 coefficients with unacceptable precision and performs corrective action by refining
5 the at least one number.

1 68. The data analysis system of claim 67 wherein the transform comprises
2 a transform matrix and wherein the transformer refines the at least one number by
3 applying a refinement matrix for increasing precision of the incremental calculation of
4 the transform constants.

1 69. The data analysis system of claim 68 wherein the refinement matrix
2 comprises $I + {}_d D_{m+1} D_m^{-1}$.

1 70. The data analysis system of claim 68 wherein the refinement matrix is
2 based on approximately calculated transform constants.

1 71. The data analysis system of claim 70 wherein the refinement matrix is
2 generated offline or at initialization.

1 72. The data analysis system of claim 69 wherein the refinement matrix is
2 generated by recognizing that an approximate transform is invertible, generating the
3 refinement matrix given by $I + {}_d D_{m+1} D_m^{-1}$, and structuring the transform for efficient
4 computation.

1 73. The data analysis system of claim 69 wherein the refinement matrix is
2 generated by recognizing that recovery of the nth column of a transform matrix for
3 generating the transform is impossible, calculating a pseudo inverse for a portion of
4 the transform matrix and generating an approximation for the refinement matrix
5 using the pseudo inverse for the transform matrix.

1 74. The data analysis system of claim 73 wherein the approximation of the
2 refinement matrix comprises $I + {}_d D_{1,d} \tilde{D}_0$.

1 75. The data analysis system of claim 66 wherein the transformer
2 determines whether to perform a corrective action by determining whether an error
3 resulting from terminating the incremental calculation is acceptable and performs
4 corrective action by aborting the incremental calculation of a transform coefficient.

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1 76. The data analysis system of claim 75 wherein the transformer
2 terminates the incremental calculation when a determination is made that the
3 incremental calculation will result in a number that is projected to be within a
4 predetermined range.

1 77. The data analysis system of claim 76 wherein the number that is
2 projected to be within a predetermined range comprises a transform coefficient that
3 does satisfy a precision requirement.

1 78. The data analysis system of claim 76 wherein the transformer
2 terminates the incremental calculation when a refinement to the transform coefficient
3 is determined not to change the result.

1 79. The data analysis system of claim 78 wherein the transformer
2 determines that a refinement to the transform coefficient will not change the result
3 when, after checking the relative magnitudes of the results of the incremental
4 calculations, an intermediate calculation of at least one transform coefficient is small
5 compared to the intermediate calculation of another transform coefficient.

1 80. The data analysis system of claim 78 wherein the transformer
2 determines that a refinement to the transform coefficient will not change the result
3 when, after checking the magnitude of the results of at least one incremental
4 calculation, at least one intermediate calculation of the transform coefficient is less
5 than a predetermined threshold.

1 81. The data analysis system of claim 66 wherein the transformer
2 determines that a corrective action is to be determined by determining that a
3 transform coefficient is going to be within a predetermined range of zero and
4 performs corrective action by aborting the incremental calculation of the transform
5 coefficient.

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